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Visual recovery after scleral buckling for macula-off retinal detachments: An optical coherence tomography study

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Purpose. *To assess the postoperative macular reattachment through OCT3 in eyes treated with episcleral surgery due to macula-off rhegmatogenous retinal detachment, as well as to verify if there is a statistically relevant relation between the persistence of a subfoveal detachment and poor postoperative functional recovery.*
Methods. *Twelve eyes of 12 patients who underwent episcleral surgery due to macula-off rhegmatogenous retinal detachment were enrolled and examined in a prospective study. Exclusion criteria were the following: traumatic retinal detachments, detachment relapses, macular holes, amblyopia, and grade B proliferative vitreoretinopathy or higher. The time period from the onset of subjective symptoms of retinal detachment to retinal surgery ranged from 3 to 7 days. All patients were evaluated in the preoperative and the postoperative period (after 1, 3, and 6 months) through measurement of visual acuity by ETDRS charts, fundus photographs, and macular tomography with OCT3. The postoperative tomography outcomes and the visual acuity were statistically examined using the Mann-Whitney U-test.*
Results. *One month after surgery, despite the macular reattachment assessable ophthalmoscopically and through fundus photographs, the OCT examination showed macular subretinal fluid persistence in 66.6% of cases. After 3 and 6 months, the persistence of such foveal detachment was respectively observed in 41.6% and in 33.3% of cases. Moreover, the macular subretinal fluid persistence in the postoperative period showed a statistically significant relation with poor functional recovery.*
Conclusions. *Delayed or incomplete visual recovery after episcleral surgery for macula-off retinal detachment may be related to macular subretinal fluid persistence, assessable with tomography and not visible ophthalmoscopically. (Eur J Ophthalmol 2007; 17: 790-6)*

Key Words. *Optical coherence tomography, Rhegmatogenous retinal detachment, Scleral buckling*

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INTRODUCTION

Each year rhegmatogenous retinal detachment (RRD) affects approximately 1 patient out of 10,000 and remains an important cause of visual impairment, despite surgical improvements (1). As a matter of fact, against more and more satisfactory anatomic results, the functional results after episcleral surgery are still relatively disappointing. It is now known that final visual results depend on different factors, but the most significant is the presence of preoperative macular damage. Around 90% of macula-on retinal detachments keep the same preoperative vision after surgery, while for macula-off detachments, incomplete functional recovery is observed in relation to a low preop-

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erative visual acuity with central retinal damage (2). The reasons for such a discrepancy between anatomic and functional results after macula-off RRDs treated with episcleral surgery are mainly unknown.

The introduction of optical coherence tomography (OCT) has offered new prospects, allowing a more accurate examination of the microscopic retinal anatomy and giving almost histologic information on the pre- and postoperative macular conditions. In particular, several studies carried out by using the OCT2 postulated that poor postoperative functional recovery in patients with macula-off RRD could be caused by the presence of subretinal fluid at the fovea, even several months after surgery (3-6). However, not all authors agreed with this assumption (7).

The present study aims to assess the possible postoperative persistence of foveal subretinal fluid by OCT3 (definition: 6-10 μm versus 10-20 μm of the OCT2), as well as to relate the tomographic outcomes with visual acuity development, in order to establish whether a statistically significant relation exists between the persistence of the subclinical macular retinal detachments and poor or incomplete functional recovery.

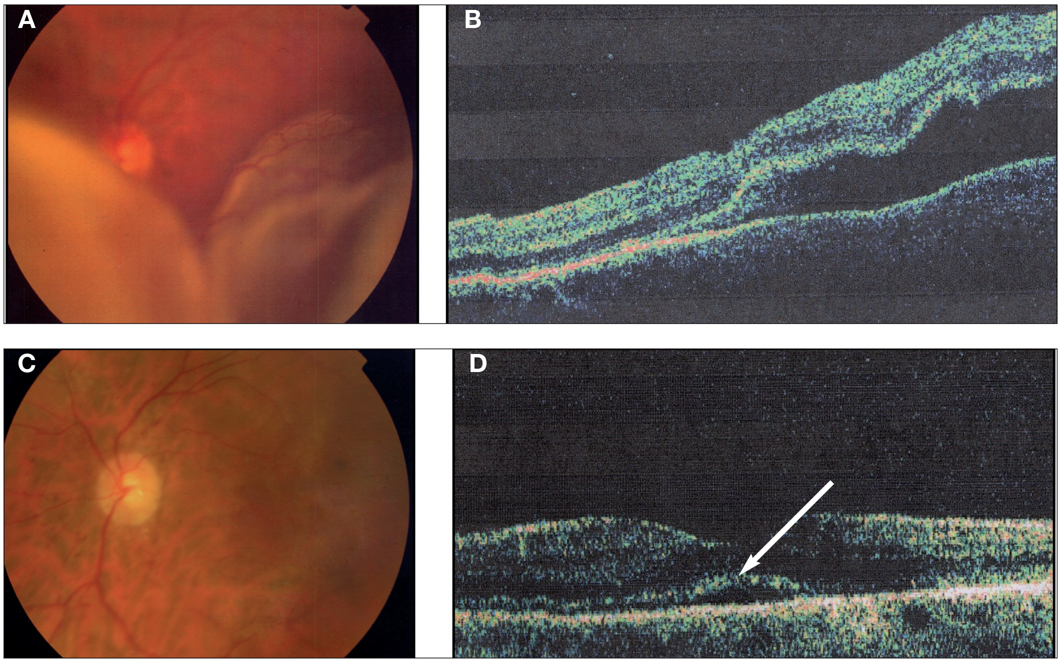
PATIENTS AND METHODS

A consecutive prospective series of 12 patients with RRD involving the macular region was enrolled at the Department of Ophthalmology of the Policlinico in Modena between December 2004 and June 2005. The age of the patients (6 men and 6 women) ranged between 46 and 79 years (mean age 62.80±10.54). The time between the occurrence of the RRD, assessed according to the symptoms the patient reported, and the surgical treatment ranged between 3 and 7 days (mean time 5.08 ± 1.56). All patients showed spontaneous RRD with one or more retinal breaks. Only 2 out of 12 patients showed a grade A proliferative vitreoretinopathy (PVR). Patients with traumatic retinal detachments, detachment relapses, macular holes, amblyopia, and grade B PVR or higher were not enrolled in the study. All patients underwent episcleral surgery (scleral buckling and/or encircling). Subretinal fluid drainage was carried out in 9 out of 12 patients and an intravitreal injection of gas (C_3F_8) was administered in all patients except one (Tab. I). In no cases did intra- or postoperative complications occur. Patients were assessed before and after surgery with ophthalmoscopy through a 90 D Volk lens and a three-mirror Goldmann lens. A pre- and postoperative (1 month after the surgical operation) photograph of the fundus was taken (Topcon fluorangiograph). Visual acuity was assessed in the preoperative period, at discharge, and then after 1 month, 3 months, and 6 months, by means of the ETDRS charts according to the number of letters the patients read and converted to logMAR (logarithm of the minimum angle of resolution) for the purpose of analysis. The tomographic images of the macula were taken in the preoperative period and after 1, 3, and 6 months, by OCT3000 (Carl Zeiss Ophthalmic Systems, Dublin, CA, USA). The macula of each patient was examined through 5-mm horizontal and vertical scans (90° and 180°). The possible presence of an optically empty hyporeflecting space at the subfoveal level was considered as a subretinal fluid accumulation. The relation between subretinal fluid and the improvement in postoperative visual acuity was studied by Mann-Whitney *U*-test for statistical analysis. Values of $p<0.05$ were considered statistically significant.

TABLE I - PATIENTS

Patient	Sex	Age, yr	Detachment duration, d	PVR	Eye, break number	Kind of operation
1. RC	F	50	3	No	RE, 1	B+EV+D+GAS
2. GI	F	75	6	No	RE, 2	B+E+EV+D+GAS
3. RE	M	61	7	No	RE, 1	E+B+D
4. FP	M	63	3	No	RE, 1	E+D+GAS
5. LL	F	66	5	No	RE, 1	B+D+GAS
6. GE	M	67	6	No	LE, 1	B+EV+D+GAS
7. PG	M	62	5	No	LE, 2	B+EV+D+GAS
8. CB	F	71	7	No	RE, 1	E+EV+GAS
9. AR	M	47	7	Yes	LE, 1	E+EV+D+GAS
10. RE	M	67	5	Yes	LE, 1	E+B+EV+D+GAS
11. TL	F	79	4	No	LE, 1	B+EV+D+GAS
12. BP	F	46	3	No	RE, 1	E+EV+D+GAS

PVR = Proliferative vitreoretinopathy; B = Buckling; EV = Evacuative puncture; D = Diathermy; E = Encircling



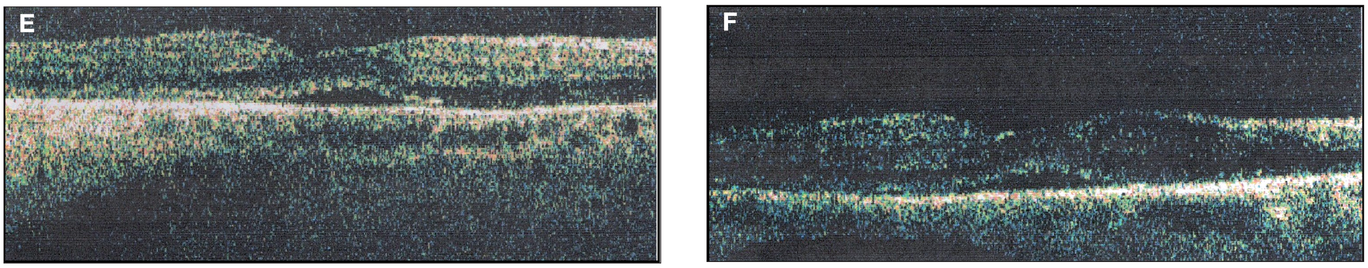


Fig. 1 - *Case 11: a 79-year-old patient with hand movement (logMAR = 3.00) preoperative visual acuity. The preoperative fundus picture* **(A)** *shows a mainly inferior retinal detachment involving the macula. The preoperative optical coherence tomography (OCT)* **(B)** *confirms the presence of macular subretinal fluid with foveal architecture alteration. The fundus picture taken 1 month after surgery* **(C)** *shows apparently normal macula, while the OCT* **(D)** *reveals the persistence of macular subretinal fluid protrusion (arrow), not clinically detectable. The same subfoveal detachment is still detectable by tomography 3 months* **(E)** *and 6 months* **(F)** *after surgery.*

RESULTS

At hospitalization, the preoperative visual acuity with the best correction converted to logMAR varied from 3.00 (0 letters) to 0.70 (20 letters). Refraction was between +1.00 D and -13.00 D. In all 12 cases the tomography showed a macular involvement, with different grades of retinal edema and neuroepithelial detachment.

At discharge, the visual acuity improved in all cases and varied from 2.00 (0 letters) to 0.40 (35 letters) (Tab. II). On ophthalmoscopic examination the retina appeared adherent in 100% of the cases.

One month after surgery, the biomicroscopic examination and the photograph of the postoperative fundus showed a macular reattachment in all 12 cases. However, macula tomographic scans revealed the presence of subretinal fluid in 8 out of 12 cases (66.6%) (Fig. 1). After 3 months the OCT showed the presence of a foveal detachment in 5 cases (41.6%) and after 6 months in 4 cases (33.3%) (Fig. 2). The only patient who received intravitreal tamponade using gas (Tab. II) did not show the persistence of subretinal fluid in OCT tests during the various control visits; nevertheless, given the reduced number of patients involved, a statistically significant difference between those tamponed with gas and those not tamponed with gas cannot be established.

The general progress of visual acuity after 1, 3, and 6 months was as follows (Tab. III):

After 1 month: 1.00 (1 letter) to 0.20 (41 letters)

After 3 months: 1.00 (5 letters) to 0.10 (49 letters)

After 6 months: 0.80 (10 letters) to 0.10 (50 letters).

At each visit, visual recovery was higher in the patient group without subretinal fluid persistence detected by OCT compared with the group with subretinal fluid persistence (Tab. IV, Fig. 3).

Statistical analysis with the Mann-Whitney *U*-test proved

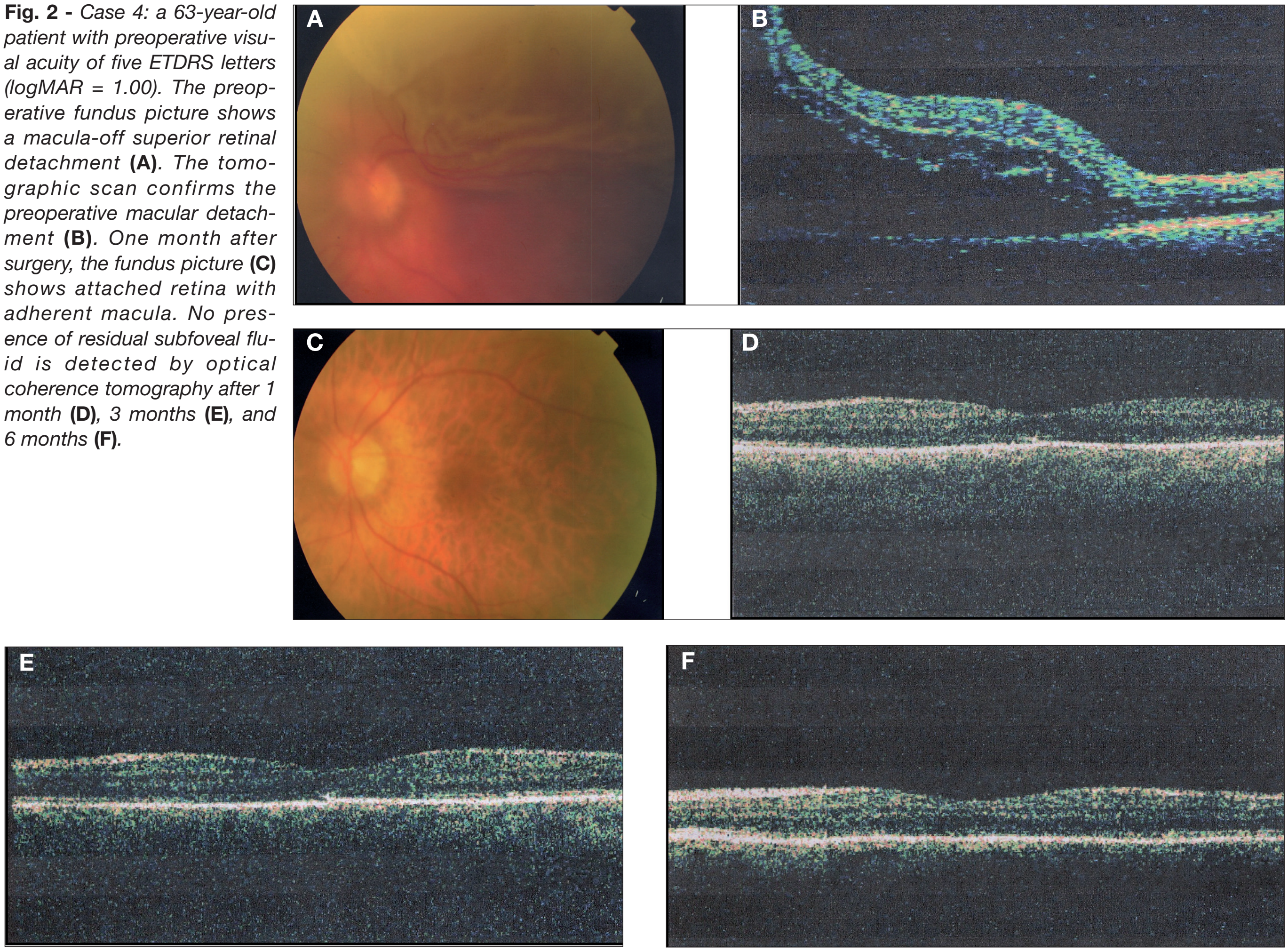


Fig. 2 - *Case 4: a 63-year-old patient with preoperative visual acuity of five ETDRS letters (logMAR = 1.00). The preoperative fundus picture shows a macula-off superior retinal detachment* **(A)**. *The tomographic scan confirms the preoperative macular detachment* **(B)**. *One month after surgery, the fundus picture* **(C)** *shows attached retina with adherent macula. No presence of residual subfoveal fluid is detected by optical coherence tomography after 1 month* **(D)**, *3 months* **(E)**, *and 6 months* **(F)**.

a significant correlation ($p<0.05$) between poor recovery of visual acuity and the presence of subretinal fluid detected by OCT (after 1 month: $p=0.0106$; after 3 months: $p=0.0044$; after 6 months: $p=0.006$).

DISCUSSION

Incomplete visual recovery after successful episcleral surgery on macula-off RRD was ascribed to various factors. For many decades experts have considered elements such as the presence of macular cystic degeneration, the retinal detachment duration, and the preoperative visual acuity to be important prognostic factors (8-12). Moreover, poor functional recovery may be related to the occurrence of various postoperative pathologic conditions, such as cystoid macular edema, epiretinal membranes, pigment migration, or retinal folds (13-15). However, many cases of poor postoperative

TABLE II - PRE- AND POSTOPERATIVE VISUAL ACUITY

Patient	Preoperative vision, logMAR (ETDRS)	Refraction error, diopters	Postoperative vision at discharge, logMAR (ETDRS)
1. RC	0.70 (20 letters)	−7.50	0.50 (27 letters)
2. GI	3.00 (0 letters)	−1.00	0.50 (28 letters)
3. RE	0.70 (20 letters)	−9.00	0.60 (25 letters)
4. FP	1.00 (5 letters)	−1.00	0.40 (35 letters)
5. LL	1.00 (3 letters)	−0.75	0.40 (33 letters)
6. GE	3.00 (0 letters)	−1.00	0.80 (15 letters)
7. PG	2.00 (0 letters)	+1.00	1.00 (5 letters)
8. CB	3.00 (0 letters)	−13.00	2.00 (0 letters)
9. AR	3.00 (0 letters)	−2.00	2.00 (0 letters)
10. RE	3.00 (0 letters)	−1.50	1.00 (1 letter)
11. TL	3.00 (0 letters)	0.00	2.00 (0 letters)
12. BP	3.00 (0 letters)	−7.00	2.00 (0 letters)

TABLE III - VISUAL ACUITY AFTER 1, 3, AND 6 MONTHS, AND SUBRETINAL FLUID PERSISTENCE

Postoperative vision after 1 month, logMAR (ETDRS)	Postoperative vision after 3 months, logMAR (ETDRS)	Postoperative vision after 6 months, logMAR (ETDRS)	Presence of subretinal fluid detected by OCT, after 1 mo/after 3 mo/after 6 mo
0.20 (41 letters)	0.20 (43 letters)	0.20 (45 letters)	–/–/–
0.40 (39 letters)	0.20 (42 letters)	0.10 (47 letters)	–/–/–
0.40 (35 letters)	0.30 (40 letters)	0.20 (42 letters)	–/–/–
0.30 (40 letters)	0.20 (45 letters)	0.10 (49 letters)	–/–/–
0.30 (36 letters)	0.10 (49 letters)	0.10 (50 letters)	+/–/–
0.50 (27 letters)	0.20 (41 letters)	0.10 (50 letters)	+/–/–
0.50 (26 letters)	0.20 (41 letters)	0.20 (45 letters)	+/–/–
0.90 (6 letters)	0.50 (27 letters)	0.20 (43 letters)	+/+/–
1.00 (1 letter)	1.00 (5 letters)	0.80 (11 letters)	+/+/+
0.50 (26 letters)	0.30 (39 letters)	0.20 (41 letters)	+/+/+
0.90 (6 letters)	0.90 (10 letters)	0.50 (28 letters)	+/+/+
1.00 (4 letters)	0.40 (31 letters)	0.30 (40 letters)	+/+/+

TABLE IV - VISUAL ACUITY DEVELOPMENT

	1 mo	3 mo	6 mo
No subretinal fluid	0.40–0.20 (35–41 letters)	0.30–0.10 (40–49 letters)	0.20–0.10 (42–50 letters)
Subretinal fluid	1.00–0.30 (1–36 letters)	1.00–0.30 (5–39 letters)	0.80–0.20 (11–41 letters)

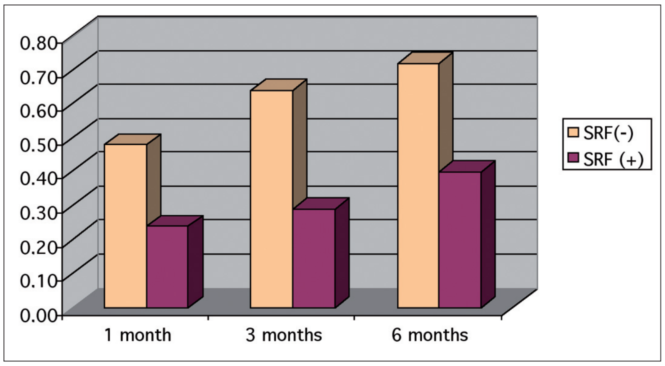


Fig. 3 - *Visual acuity course (SRF = Subretinal fluid).*

functional recovery are reported even in patients without such conditions. With the introduction of OCT it has been possible to better investigate the problem of the gap between anatomic and functional success after episcleral surgery, collecting detailed information on retinal and macular microanatomy in the pre- and postoperative period. First of all, owing to clinical studies carried out with OCT, it has been demonstrated that the negative preoperative prognostic factors for functional recovery are the fovea distance from the nearest area affected by the detachment, and the height of the macular retinal detachment (16, 17). In addition, delayed or absent postoperative visual functional recovery in the macula-off RRDs was postulated as being related to subretinal fluid permanence at the foveal level, not visible with ophthalmoscopy or angiography. Machemer (18), while studying the follow-up period of retinal detachments in owl monkeys, was the first to observe the presence of small subfoveal lesions and considered them as residual detachments of the neuroepithelium related to macular subretinal fluid persistence. Machemer's theory has been recently confirmed by several studies performed using OCT (3-7). With OCT it has been demonstrated that the reabsorption rate of the residual subfoveal fluid in the postoperative period after vitrectomy is higher than after episcleral surgery (19). Subfoveal fluid accumulation may occur in the postoperative period and be detectable with OCT even in eyes with macula-on RRD. This outcome is related to a visual acuity decrease that in such cases never reaches preoperative values (20).

Our study was carried out by OCT3 (definition of about

6–10 μm), whereas the above-mentioned clinical trials used OCT2 (definition of 10–20 μm), to carry out a more detailed investigation of the presence of alterations in the retinal and foveolar architecture that could explain incomplete or delayed functional recovery after episcleral surgery due to macula-off RRD. We then looked for any possible statistical significance between the two factors.

In all 12 patients, preoperative tomography showed the presence of a retinal detachment involving the macular region, with different edema and neuroepithelium detachment grades. In the postoperative scans, however, the presence of two different conditions was observed: patients with perfectly adherent macula without residual edema and patients with persistent subretinal foveal fluid, not detectable with fundus biomicroscopy. These data are difficult to understand because 11 out of 12 patients underwent evacuative puncture and in all cases the anatomic closure of breaks was achieved through buckling and/or encircling. However, it is possible that a residual quantity of fluid, even several months after surgery, may be reabsorbed more slowly at the subfoveal level due to lower effectiveness of the retinal pigment epithelium (RPE) pump-effect in this region. The reason for the presence of foveal subretinal fluid could alternatively be related to vitreal factors that could cause a mechanical traction favoring the persistence of a serous detachment. It was also suggested that the origin of the serum leakage could be due to the presence of a scleral or choroidal inflammatory reaction induced by the encircling buckle (19). Others, however, postulate the role of a possible alteration of the subfoveal retinal and choroidal circle caused by the encircling band (21-23).

In the present study, the development of visual acuity was related to the tomographic result, and statistical analysis demonstrated a significant correlation between poor visual recovery and the evidence of macular subretinal fluid. The real reasons for this relation are not completely clear. One of the hypotheses we made is that the presence of subfoveal fluid prevents the retinal layers from properly reattaching to each other, particularly between the RPE and the photoreceptor layer. In addition, a slowdown or a blockage in the transport of oxygen, photomaterials, glucose, and ions may occur between the RPE and the sensorial retina, thus precluding complete functional recovery from happening.

In conclusion, OCT3 is an irreplaceable instrument for the postoperative assessment of macula in patients who have undergone surgery for macula-off RRD, because it permits detection of the presence of small residual neuroepithelium detachments that are not visible with ophthalmoscopy. Moreover, the persistence of foveal subretinal fluid in these patients shows a statistically significant relation to low postoperative visual recovery.

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